Advanced theory of computation

Academic Year: (2021 / 2022) **Review date: 30-06-2021**

Department assigned to the subject: Computer Science and Engineering Department

Coordinating teacher: ALONSO WEBER, JUAN MANUEL

Type: Compulsory ECTS Credits : 6.0

Year : XX Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Automata and Formal Language Theory (Course 2 / Semester 1)
Discrete Mathematics (Course 1 / Semester 2)

DESCRIPTION OF CONTENTS: PROGRAMME

Relevant contents:
- Computational Complexity and Computational Cost.
- Computational Cost of Structured and Recursive Programs
- Computability and Decidability
- Turing Machines (Multi-tape, Non deterministic)
- Problem Reduction
- Complexity Classes P, NP, NP-Complete and NP-Hard.
- Other Models of Computation

PROGRAMME
1. Computational Cost of Algorithms.
  1.1 Computational Complexity and Computational Cost.
  1.2 Computational Cost of Structured Programs
  1.3 Computational Cost of Recursive Programs
  1.4 Probabilistic Analysis

2. Introduction to Computability Theory
  2.1 Definition of Problem. Decision Problems
  2.2 Turing Machines and Decidability
  2.3 Computability and Decidability

3. Introduction to Complexity Theory
  3.1 Problem Reduction
  3.2 Classes P, NP and NP-Complete.
  3.3 Classes PSpace, NPSpace.
  3.3 Classes NP-Hard, Exp, CoP, CoNP

4. Models of Computation
  4.1 Turing Machines (Multi-tape, Non deterministic)
  4.2 Lambda-Calculus
  4.3 Cellular Automata
  4.4 Lindenmayer Systems

LEARNING ACTIVITIES AND METHODOLOGY

Theoretical lectures: 1.5 ECTS. To achieve the specific cognitive competences of the course.

Practical lectures: 1,5 ECTS. To develop the specific instrumental competences and most of the general competences, such as analysis, abstraction, problem solving and capacity to apply theoretical concepts. Besides, to develop the specific attitudinal competencies. They consist in proposing during the practical lectures a compiler/interpreter project to be developed in teamwork

Guided academic activities (in presence of the teacher): 1 ECTS. The student proposes a project according to the teacher's guidance to go deeply into some aspect of the course, followed by a public presentation.

Guided academic activities (in absence of the teacher): 1 ECTS. Exercises and complementary readings proposed by the teacher.

EXAMINATION: 0,5 ECTS. To complete the development of specific cognitive and procedimental capacities.

TUTORING SESSIONS. 0,5 ECTS
Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.

ASSESSMENT SYSTEM

The evaluation will consist in a continuous assessment and a final exam.

The continuous evaluation (65%) will address:
- practical work done by the students.
- academic activities in the presence of the professor.
- several partial exams to evaluate the students' work individually

A final-term exam (35%) to assess the extent to which the students have acquired the cognitive and procedural competences
It will consist of theoretical questions, exercises and practical problems

A minimum mark for the final-term exam (4 out of 10) is required to pass the subject.

% end-of-term-examination:	35
% of continuous assessment (assigments, laboratory, practicals…):	65

BASIC BIBLIOGRAPHY

- John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman. Introduction to Automata Theory, Languages, and Computation, Addison-Wesley 3rd Edition.
- Michael Sipser. Introduction to the Theory of Computation. 2nd ed., Boston, MA: Course Technology, 2005. ISBN: 0534950973..
- S. Wolfram. Cellular Automata and Complexity., Addison-Wesley, (1996).

ADDITIONAL BIBLIOGRAPHY

- C. Papadimitriou Computational Complexity., Addison-Wesley, 1995.
- H. S. Wilf Algorithms and Complexity., Prentice-Hall, 1986.
- Jeffrey Shallit. A Second Course in Formal Languages and Automata Theory., Cambridge University Press..